After Studying this chapter, students will be able to:

- Describe cell cycle
- Explain mitosis and stages of mitosis (by use of sketch and diagrams)
- Explain meiosis and stages of meiosis (by use of sketch and diagrams)
- Compare the processes of mitosis and meiosis
- Outline the significance of mitosis and meiosis

Subject Questions & Answers

4.1 + 4.2 Cell Cycle + Mitosis

Q.1: What is the Cell cycle and what are its main phases?

Ans Cell cycle:

Cell cycle is the series of events that take place in a eukaryotic cell from its formation to its division into two daughter cells.

Divisions of Cell cycle:

The cell cycle can be divided in two main phases

(i) Interphase (ii) Mitosis phase

(i) Interphase:

This phase lasts for about 90% of the total time of cell cycle. During interphase, the cell performs the life functions according to its specialty and prepares itself for next division.

Phases of Interphase:

Interphase, consists of the following three phases:

- *G1* Phase (First Gap Phase)
- S phase (Synthesis Phase)
- G2 Phase (Second Gap Phase)

Q.2: Discuss Interphase in detail.

Ans. Interphase:

This phase lasts for about 90% of the total time of cell cycle. During interphase, the cell performs the life functions according to its specialty and prepares itself for next division. Interphase, consists of the following three phases:

G1 Phase (First Gap Phase):

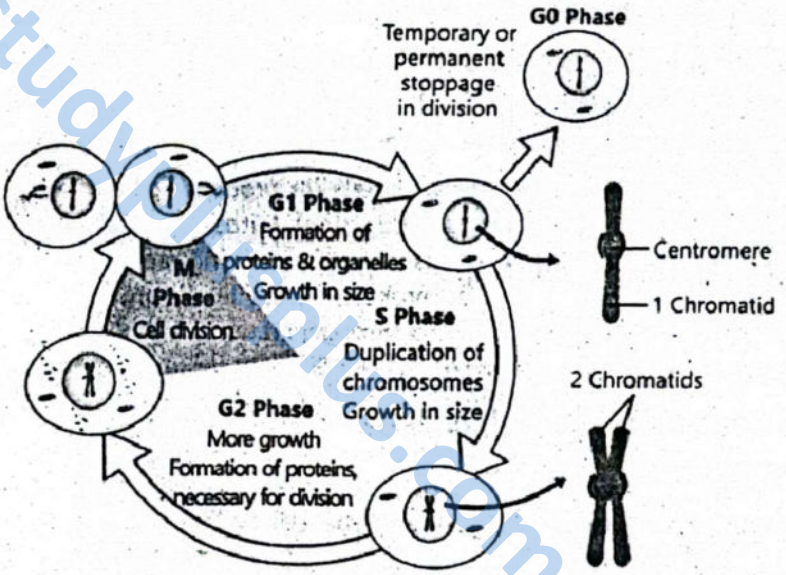
It starts from the end of the Mitosis phase. It is also called the growth phase. During this phase cell makes proteins and organelles and so grows in size. Cell also makes enzymes that are required in S phase for the replication of DNA.

S Phase (Synthesis Phase):

During this phase, the DNA of each chromosome is replicated (copied). It results in the duplication of chromosomes (each chromosome consists of two sister chromatids). The total number of chromosomes in cell remains the same.

G2 Phase (Second Gap Phase):

In this phase, the cell continues to grow and produces proteins necessary for cell division. The cell checks for any DNA damage that may have occurred during replication and makes necessary repairs. It also begins to reorganize its contents in preparation for mitosis.



Eukaryotic Cell cycle

After interphase, the cell enters the division phase and divides into the two daughter cells. The events of cell cycle are controlled by special genes. All phases occur in a sequence.

Q.3: Describe the events that occur during the phases of mitosis.

Ans. Mitosis: Mitosis is the type of cell division ip which a cell divides into two.daughter cells, each with the same number of chromosomes as were present in the parent cell.

Phases of Mitosis:

The German biologist, Walther Flemming discovered the events of mitosis in 1880s. There are two major phases of mitosis.

- Karyokinesis
- Cytokinesis

Karyokinesis:

Karyokinesis means the division of the nucleus, it is further divided into four phase:

i. Prophase **ii.** Metaphase **iii.** Anaphase **iv.** Telophase

i. Prophase: Pro means "before" and phase means "appearance". Following events occur during prophase.

- During prophase, the thread-like chromatin material condenses and makes thick visible chromosomes.
- Each chromosome consists of 2 sister chromatids attached with a single centromere.
- The nuclear envelope and nucleolus break down.
- The two centrosome of cell duplicates into two. The two centrosomes migrate to opposite side of the nucleus. When they are migrating, they make a network of microtubules called spindle fibres (complete set is called mitotic spindle).

In plant cells, there is no centrosome. Their mitotic spindle is formed by the aggregation of spindle fibres present in cytoplasm.

ii. Metaphase: Meta means "after" and phase means "appearance". Folllowing events take place during metaphase.

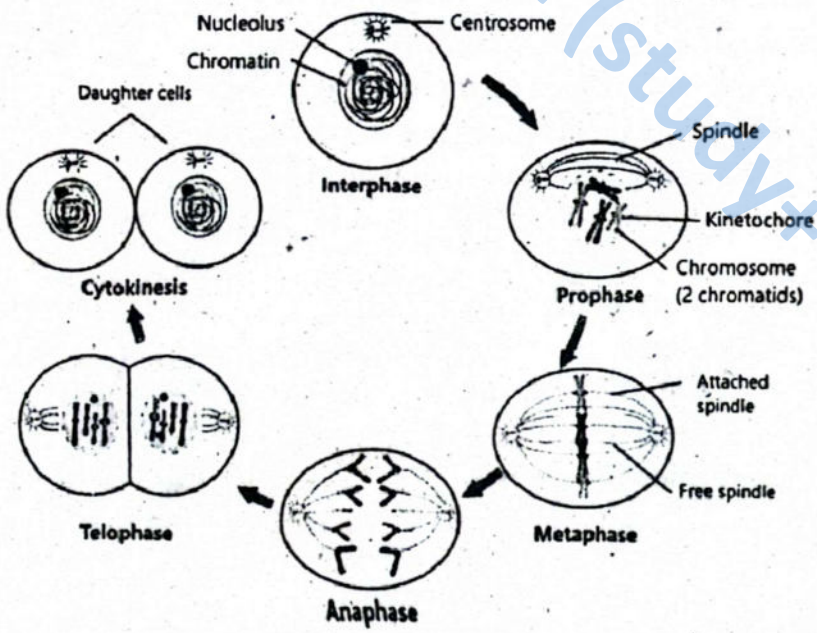
- During metaphase, some spindle fibres bind with chromosomes. They attach at the point of centromere where special kinetochore proteins are present.
- Two spindle fibres from both sides bind with one chromosome.
- The chromosomes attach with spindle fibres arrange themselves along the equator of the cell. In this way a plate is formed called metaphase plate.

iii. Anaphase: Ana means "upper" and phase means "appearance". During anaphase following events take place.

- The spindle fibres attached with chromosomes pull toward the poles.
- The chromosome's sister chromatids separate.
- Two similar sets of chromatids move towards the poles of the cell.

iv. Telophase: Telo means "end" and phase means "appearance". During telophase following events take place.

- New nuclear envelope forms around each set of separated chromosomes.
- Both sets of chromosomes unfold back into chromatin.



Phases of mitosis

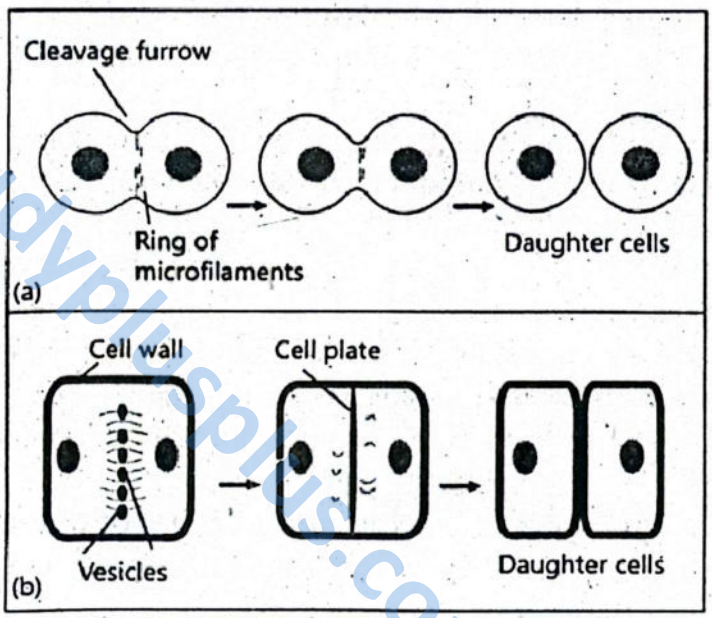
Q.4: Describe cytokines is in animal and plant cells.

Ans. Cytokinesis:

It is the division of cytoplasm.

Cytokinesis in animal cell: In animal cells, a furrow develops in the cell membrane at the equator. At this furrow, the cytoplasm has a **ring of microfilaments.** The ring contracts and the furrow moves inward. In this way parent cell is pinched into two.

Cytokinesis in plant cell: In plant cells, Golgi apparatus makes vesicles. These vesicles move to the middle and fuse to form a plate called **phragmoplast.** The plate grows outward and its membranes fuse with the cell membrane. The result is two daughter cells.



Cytokinesis; (a) in animal cell, (b) in plant cell

Q.5: Describe the significance of mitosis.

Ans. Significance of Mitosis:

Mitosis is significant in the following ways:

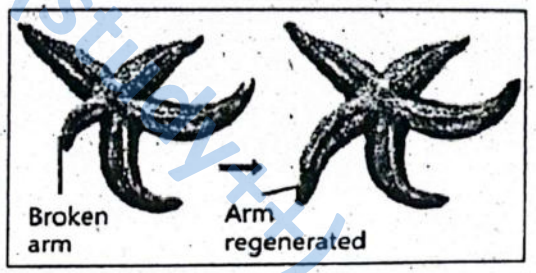
Growth: Growth in organisms means an increase in size and the number of cells. Mitosis plays a crucial role in growth by producing new cells that are identical to the original cell.

Cell Replacement:

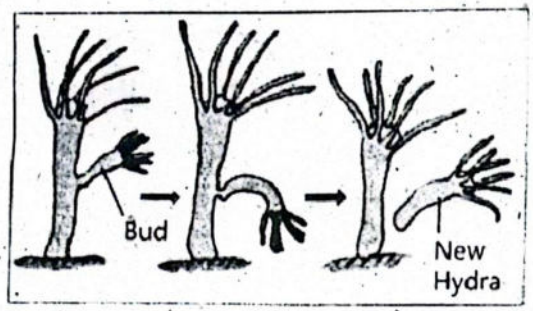
Many cells are constantly dying in our bodies. For example, the red blood cells and the cells of the walls of intestine and skin etc. These are replaced by new ones which are exact copies of the older cells. *The new cells are formed by mitosis.*

Regeneration:

Some animals can regenerate parts of the body. For this purpose, they form new cells by carrying out mitosis in the cells of remaining parts.



Regeneration in sea star



Budding in Hydra

Asexual reproduction:

Mitosis is a means for asexual reproduction. For example, Hydra reproduces asexually by budding. During this process mitosis forms a mass of cells called bud on the surface of Hydra. Mitosis continues in the cells of the bud and it grows into a new individual.

Q.6: Explain the errors in mitosis.

Ans. Errors in Mitosis

Sometimes the process of mitosis goes wrong. For example, during the anaphase of mitosis, the sister chromatids of a chromosome may fail to separate. As a result, one daughter cell receives both sister chromosomes and the other will receive none. Chromosomes may also be damaged during mitosis.

Tumors:

If the genes that regulate mitosis are mutated (changed), the cells continue to divide. Due to this uncontrolled division, masses of cells are formed. These masses are called tumors.

Benign: If the tumors remain in their original location, they are called benign.

Malignant: If they migrate and invade other tissues, they are called malignant tumors (cancer). It is called metastasis (spreading of disease).

4.3 + 4.4 Meiosis + Comparison Between Meiosis and Mitosis

Q.7: Describe the events that occur during the phases of meiosis-I and Meiosis-II.

Ans. Meiosis:

It is the type of cell division in which each daughter cell receives half the number of chromosomes as compared to the parent cell.

In meiosis, a diploid parent pell divides to produce four haploid daughter cells.

Meiosis was discovered in 1876 by a German biologist Oscar Hertwig

Phases of Meiosis

Meiosis consists of two divisions.

- Meiosis-I
- Meiosis II

Meiosis-I:

In meiosis-I, the homologous chromosomes in a diploid cell separate so two haploid *daughter cells* are produced. It is subdivided into following phases.

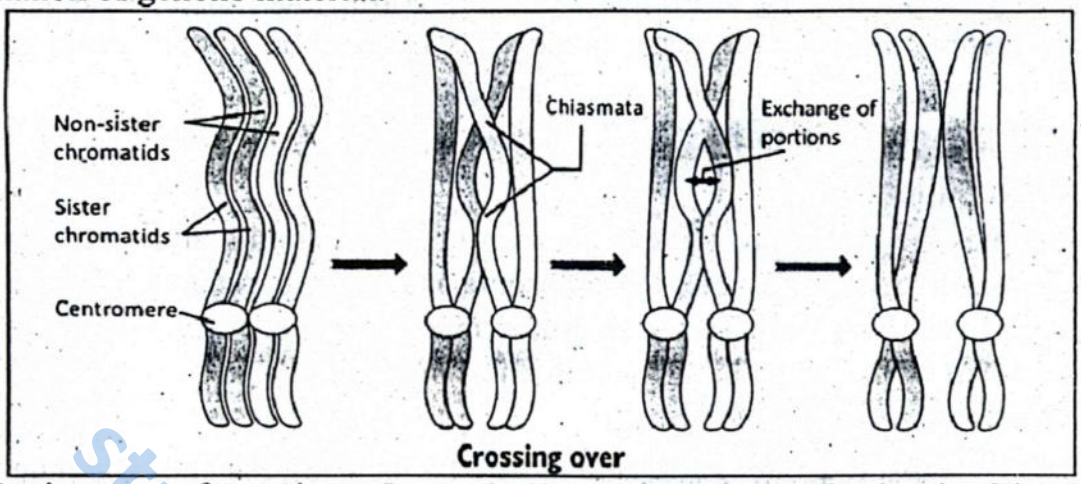
- Prophase-I
- Metaphase-I
- Anaphase-I
- Telophase-I

Prophase-I

During this stage, chromatin condenses and takes the shape of chromosomes. Each chromosome consists of two sister chromatids, because the DNA has already replicated before meiosis.

Homologous chromosomes move dose together. They pair up in a process called **synapsis.** Each pair of homologous chromosomes is referred called **tetrad.** Non-sister chromatids of homologous chromosomes become "zipped" together, forming X-shaped

structures called **chiasmata.** Each chiasma is the site for crossing over i.e., exchange of portions of chromosomes between non-sister chromatids. Crossing over leads to recombination of genetic material.



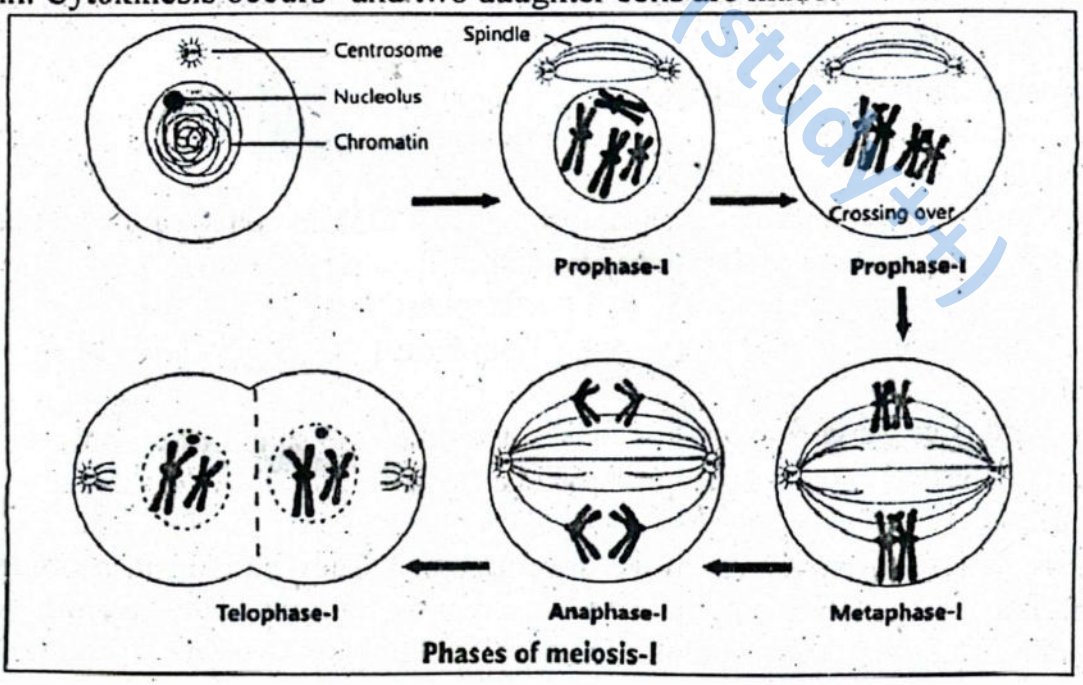
Crossing over

Other events of prophase-I are similar to prophase of mitosis. The "nucleoli disappear and nuclear envelope breaks. Centrioles migrate to opposite poles and make spindle fibres to which chromosomes attach.

Metaphase-I: The tetrads attached with spindle fibres align along the equator. In this way, they form metaphase plate. Two spindle fibres from both poles attach with one chromosome of the pair.

Anaphase-I: Each spindle fiber attached with a single chromosome pulls towards the pole. In this way the paired chromosomes are separated. One chromosome of each pair is pulled toward one pole and the other towards opposite pole. So, two haploid sets of chromosomes are formed. Each chrompsome still contains a pair of sister chromatids.

Telophase-I: Spindles disappear and a new nuclear envelope is made around each haploid set. Nucleolus also reforms during Telophase - I the chromosome uncoil into chromatin. Cytokinesis occurs "and two daughter cells are made.



Phases of meiosis-I

Q.8: Write a note on Meiosis - II.

Ans. Meiosis-II

Meiosis-II closely resembles mitosis and consists of four phases:

• Prophase-II • Metaphase-II • Anaphase-II • Telophase-II

Prophase-II

During prophase-II, the nucleoli and nuclear envelope disappear, and the chromatin condenses. Centrioles move to the poles, forming spindle fibres.

Metaphase-II

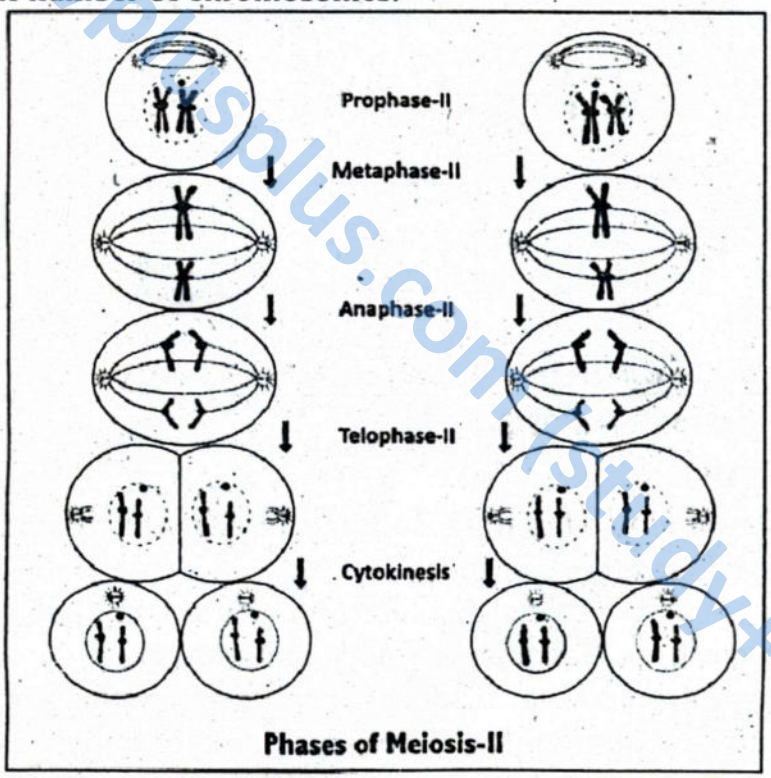
During metaphase-II, spindle fibres attach to the kinetochores of chromosomes, aligning them at the cell's equator.

Anaphase-II

In anaphase-II, spindle fibres pull sister chromatids apart toward opposite poles.

Telophase II

In telophase, chromosomes uncoil back into chromatin, nuclear envelopes and nucleolus reform, and cytokinesis occurs. This results in the formation of four daughter cells, each with half number of chromosomes.



Phases of Meiosis-II

Q.9: Describe the significance of meiosis.

Ans. Significance of Meiosis

Meiosis is significanct in the following ways:

1. Meiosis maintains the number of chromosomes:

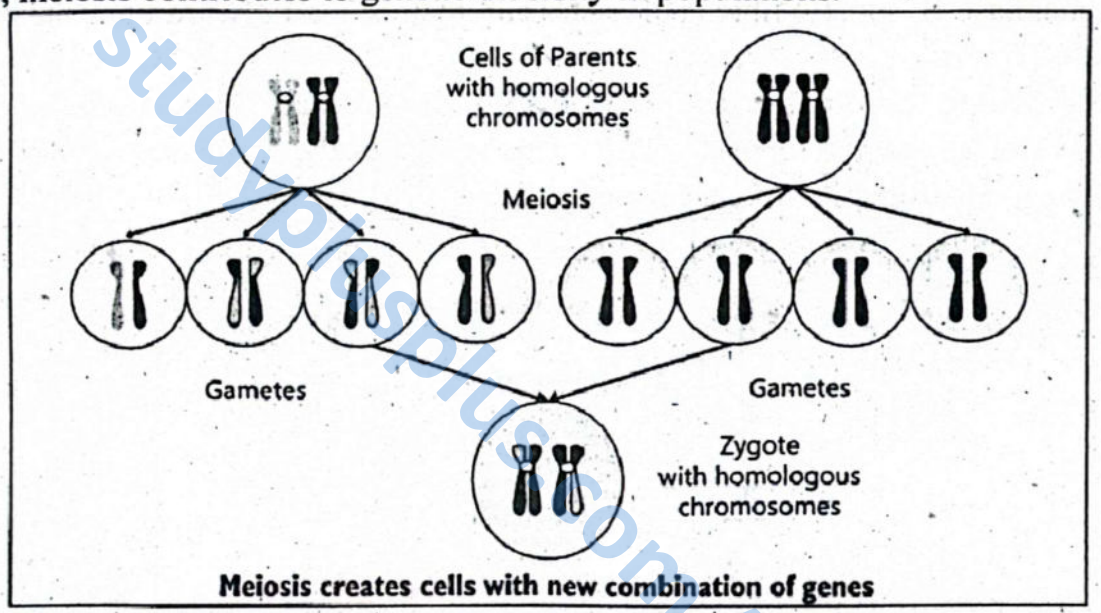
In animals, special cells in reproductive organs undergo meiosis. The daughter cells, called **gametes,** have half the number of chromosomes (with no pairs). During sexual reproduction, male and female gametes join to make the first cell (zygote) of new

generation. The original number of chromosomes is restored in zygote. It undergoes mitosis many times and develops into the new animal.

In flowering plants, specialized cells in flowers undergo meiosis. The daughter cells, called **spores,** have half number of chromosomes. These spores grow into new generation inside the flowers. This generation produces gametes by mitosis. The gametes join to make zygote with full set of chromosomes. The zygote undergoes mitosis and develops into new plant.

2. Meiosis brings genetic diversity

Crossing over creates new combinations of genes on chromosomes. Each chromosome in the gametes carries a unique set of genes. When diverse gametes from two parents combine, the resulting zygote is genetically different from both parents. In this way, meiosis contributes to genetic diversity in populations.



Meiosis creates cells with new combination of genes

Q.10: Explain the errors in meiosis.

Ans. Errors in Meiosis:

Disjunction: During meiosis-I, chromosomes separate while during meiosis-II sister chromatid separate. It is called disjunction.

Non-disjunction: Sometimes non-disjunction occurs. Due to it, the daughter cells (gametes) receive more or less than the normaln number of chromosomes. If such gametes fuse to form zygote with abnormal number of chromosomes. If such zygote develops. The resulting offspring suffers from severe medical problems.

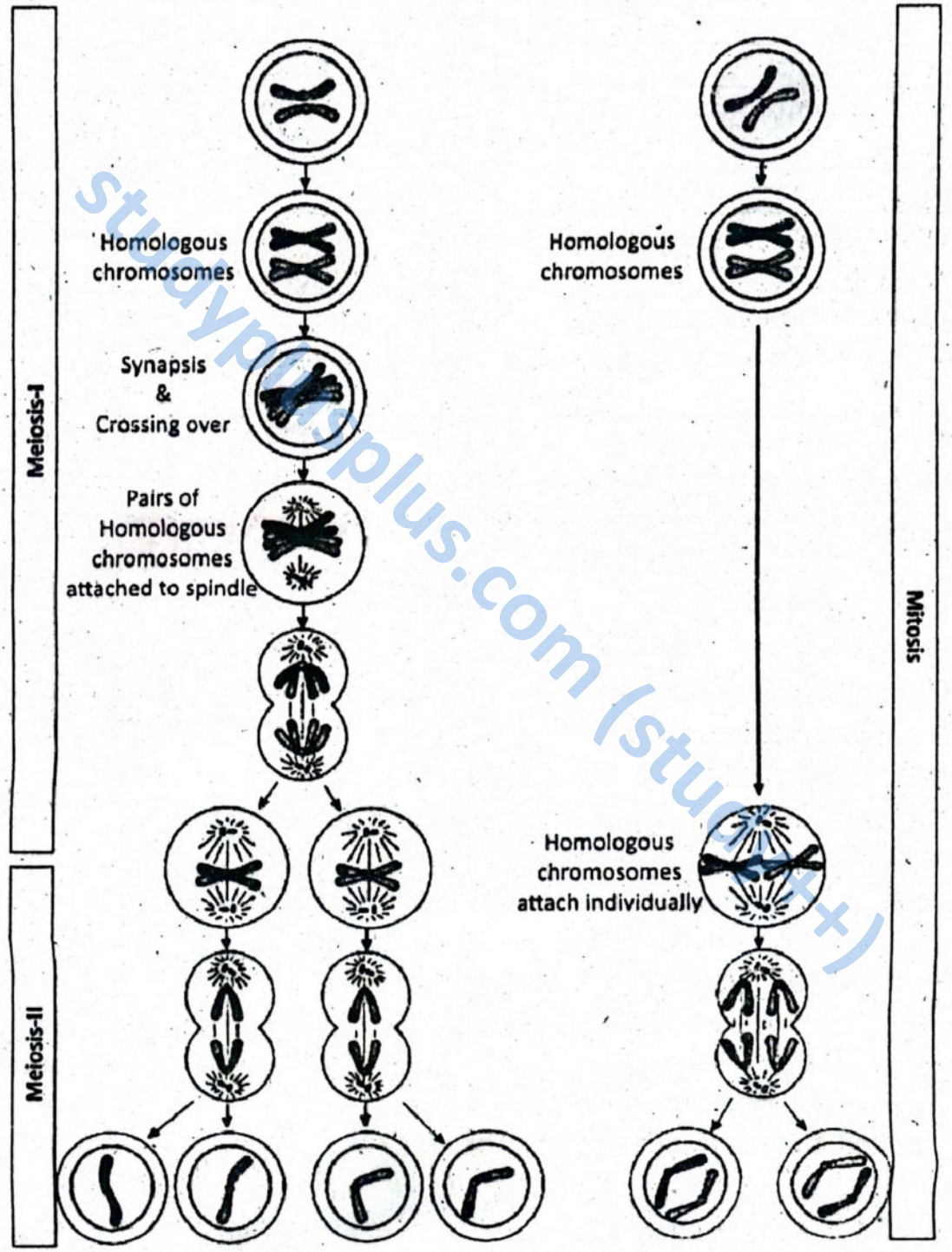
Q.11: Give a comparison between Meiosis and Mitosis:

Ans. Comparison between Meiosis and Mitosis

Similarities

1. DNA replication occurs during interphase (S phase) before both divisions.
2. Both divisions begin with a parent cell that has chromosomes in pairs.
3. In both divisions, chromatin condenses and chromosomes become visible during prophase.

4. Both mitosis and meiosis involve the formation of a spindle apparatus.
5. Both involve prophase, metaphase, anaphase, and telophase. However, meiosis has two rounds i.e., meiosis-I and meiosis-II.
6. In both divisions, sister chromatids separate. In mitosis, it happens during anaphase. In meiosis, it happens in anaphase II.
7. Cytokinesis occurs at the end of both divisions. During cytokinesis, the cytoplasm divides and two new cells are formed.



Comparison between meiosis and mitosis

Q.12: Give differences between Mitosis and Meiosis.

Ans. Difference between Mitosis and Meiosis:

Mitosis	Meiosis
A parent cell divides only once, two daughter cells are produced.	A parent cells undergoes two divisions; four daughter cells are produced.
Chromosomes number in daughter cells remains the same as the parent cells.	The Chromosomes number is reduced by half in daughter cells.
Variations are not generated.	Variations due to crossing over.
Occur in somatic cells.	Occur in germ line cells.
Homologous chromosomes do not form pairs.	Homologous chromosomes form pair.
No crossing over occurs during prophase.	Crossing over occurs during prophase.
Single chromosome aligns to form a metaphase plate.	Homologous pairs align to form a metaphase plate.
During anaphase chromosomes break and individual chromatids are pulled towards poles.	During anaphase-I individual chromosomes are pulled towards poles.
Occurs for growth, development and maintainance of multicellular organisms.	Occurs for producing gametes in animals and spores in plants for sexual reproduction.

Conceptual Long Questions

1. How do telophase-I and telophase-II differ during meiosis in animal cells?

Ans. Cells remain diploid at the end of telophase I, but are haploid at the end of telophase II. Daughter cells form a cell plate to divide during telophase I, but divide by cytokinesis during telophase II.

2. What is the hardest phase to identify in mitosis?

Ans. DNA is most difficult to visualize at prophase stage of mitosis.

Explanation:

At prophase stage, no well defined chromosomes are present. DNA is present in the form of thin chromatin fibers that are difficult to visualize under the microscope.

3. Can there be mitosis without DNA?

Ans. No. There cannot be mitosis involves splitting of chromosomes at a centromere there by separating the replicated chromosomes. Without DNA replication. DNA cannot be divided equally into two daughter cell.

4. What would happen if mitosis never existed?

Ans. If mitosis does not occur two things will happen the organism will be unable to grow, and it will be unable to replace dead cells as well as be unable to heal wounds. The only way a baby can grow into an adult is through mitosis.

5. How meiosis II is similar to mitosis?

Ans. Meiosis II is similar to mitosis in a number of ways, including:

- They produce two identical nuclei by separating one chromatid from each chromosome.
- The number of chromosomes in each daughter cell remain the same as the number of chromosomes in the mother cell.
- Both have stages including prophase, metaphase anaphase and telophase
- The centrosome duplicates during both the cell divisions.

Information

G0 Phase: Many cells stop dividing and start performing their specific functions. This phase is called G0 phase. Many cells (e.g. neurons) remain in G0 for indefinite periods. Some cell (e.g. cells of liver and kidney) remain in G0 phase temporarily. Other cells (e.g. epithelial cells) do not enter G0 and continue to divide throughout life.

Your body consists of about 200 trillion cells. All these cells were formed from a single cell (zygote) at the start of your life. Millions of cell divisions occurred while your body was reaching its present form. In each of these divisions the genetic material was equally distributed between the daughter cells. It happened through mitosis.

Key Points

- Cell cycle is series of events starting after cell division to the next division.
- By mitosis a cell divides into two daughter cells and each daughter cell receives the same number of chromosomes as were present in the parent cell.
- During prophase of mitosis chromatin condenses and takes the shape of chromosomes. Centrioles duplicate and make spindle fibres.
- During metaphase of mitosis one chromosome is attached with two spindle fibres from opposite poles.
- During anaphase of mitosis centromeres of chromosomes divide and sister chromatids separate.
- During telophase of mitosis new nuclear envelope forms around each set of chromosomes.
- Mitosis occurs during development, growth, cell replacement, regeneration and asexual reproduction.
- Meiosis is the type of cell division, in which each daughter cell receives half the number of chromosomes as compared to parental cell.
- During prophase I of meiosis, homologous chromosomes form-pairs. The non-sister chromatids of homologous chromosomes exchange their segments in crossing over.
- During metaphase I of meiosis, one pair of homologous chromosomes is attached with two spindle fibres from opposite poles.
- During anaphase I of meiosis, hornologous chromosomes are pulled apart forming two diploid sets at opposite poles.
- During telophase I of meiosis, spindle fibres disappear, and new nuclear envelope surrounds each haploid set.
- *Meiosis maintains the* chromosome number in next generation, by making haploid gametes. Meiosis produces variations in next generations.

Additional MCQs

4.1 Cell Cycle

4.2 Mitosis

1. **Interphase lasts for about _____ of the total time of cell cycle.**
   (a) 60% (b) 70% (c) 80% (d) 90%
2. **The longest phase of cell cycle is:**
   (a) Prophase (b) Telophase (c) Interphase (d) Metaphase
3. **The phase starts from the end of the mitosis phase is:**
   (a) G2 (b) G1 (c) S (d) Prophase
4. **Growth phase is another name of:**
   (a) G1 (b) G2 (c) S (d) Metaphase
5. **Cell makes proteins and organelles and so grow in size during.**
   (a) Cytokinesis (b) G1 phase (c) S phase (d) G2 phase
6. **Duplication of chromosome occurs during.**
   (a) G1 phase (b) S phase (c) G2 phase (d) G0 phase
7. **Each chromosome consists of _____ sister chromatids:**
   (a) 2 (b) 3 (c) 4 (d) 5
8. **Cell grows and produces proteins necessary for cell division during:**
   (a) S phase (b) G1 phase (c) G2 phase (d) None of these
9. **Cell begins to recognize its contents in preparation for mitosis during:**
   (a) G0 phase (b) S phase (c) G1 phase (d) G2 phase
10. **In division phase, the cell divides into:**
    (a) 2 daughter cells (b) 3 daughter cells (c) 4 daughter cells (d) 5 daughter cells
11. **Many cells stop dividing and start performing their specific functions in:**
    (a) G0 phase (b) G1 phase (c) S phase (d) G2 phase
12. **Which cells do not enter G0 and continue to divide throughout life.**
    (a) Liver cells (b) Epithelial cells (c) Kidney cells (d) Brain cells
13. **The cell divides its genetic material equally into two new identical cells during:**
    (a) G0 phase (b) G1 phase (c) G2 phase (d) M phase
14. **In eukaryotes mitosis occurs in the:**
    (a) Germs cells (b) Somatic cells (c) Daughter Cells (d) Parent cells

15. **Walther Fleming in 1880s discovered the events of:**
(a) Mitosis (b) Interphase (c) Meiosis I (d) Meiosis II

16. **Karyokinesis is the division of:**
(a) Vacuole (b) Nucleus (c) Ribosome (d) Cytoplasm

17. **Cytokinesis is the division of:**
(a) Mitochondria (b) Cell membrane (c) Cytoplasm (d) Nucleus

18. **Total major phases of mitosis are:**
(a) 3 (b) 2 (c) 6 (d) 5

19. **Karyokinesis is divided into:**
(a) 2 phases (b) 3 phases (c) 4 phases (d) 5 phases

20. **The thread like chromatin material condenses and makes thick chromosomes during:**
(a) Metaphase (b) Telophase (c) Prophase (d) Anaphase

21. **The nuclear envelope and nucleolus break down during:**
(a) Anaphase (b) Prophase (c) Telophase (d) Metaphase

22. **The centrosome of cell duplicates and each move to opposite side of the nucleus during:**
(a) Telophase (b) Anaphase (c) Metaphase (d) Prophase

23. **Centrosomes make spindle fibres during.**
(a) Anaphase (b) Telophase (c) Prophase (d) Metaphase

24. **Some spindle fibres bind with chromosomes during.**
(a) Prophase (b) Metaphase (c) Telophase (d) Anaphase

25. **Metaphase plate is formed during:**
(a) Metaphase (b) Telophase (c) Interphase (d) G0 phase

26. **The chromosomes attached with spindle fibres arrange themselves along the equator of the cell during:**
(a) Prophase (b) Metaphase (c) Anaphase (d) Telophase

27. **The spindle fibres attached with chromosomes pull towards the poles during:**
(a) Metaphase (b) Telophase (c) Anaphase (d) Prophase

28. **During this phase there are two Similar sets of chromatids which move towards the poles of the cell.**
(a) Telophase (b) Anaphase (c) Metaphase (d) Prophase

29. **During which phase of mitosis new nuclear envelope forms around each set of separated chromosomes.**
(a) Metaphase (b) Anaphase (c) Prophase (d) Telophase

30. **Both sets of chromosomes unfold back into chromatin during:**
(a) Prophase (b) Telophase (c) Metaphase (d) Anaphase

31. **In which phase of mitosis chromatids get separated?**
(a) Prophase (b) Anaphase (c) Telophase (d) Metaphase

32. **Cytokinesis means:**
(a) Division of cytoplasm (b) Division of nucleus
(c) Division of chromosomes (d) Division of Lysosomes

33. **Genetic material in nucleus is in loose thread like form called:**
(a) Centromere (b) Chromatin (c) Spindle fiber (d) Nucleolus

34. **Our body consists of about _____ trillion cells.**
(a) 100 (b) 200 (c) 300 (d) 400

35. **The new cells are formed by:**
(a) Mitosis (b) Meiosis (c) Interphase (d) Cytokinesis.

36. **Tumors are produced as a result of errors in:**
(a) Meiosis (b) Mitosis (c) Interphase (d) G0 phase

37. **Complete set of spindle fibre is known as:**
(a) Chromatin (b) Mitotic spindle (c) Kinetochore (d) Phragmoplast

38. **If tumors remain in their original location, they are called:**
(a) Benign (b) Malignant (c) Metastasis (d) Phragmoplast

39. **If the tumors migrate and invade other tissues, they are called:**
(a) Metastasis (b) Malignant tumors
(c) Benign (d) Chromatin

40. **Budding process is found in:**
(a) Cockroach (b) Onion (c) Hydra (d) Fern

4.3 + 4.4 Meiosis + Comparison Between Meiosis and Mitosis

41. **In meiosis, a diploid parent cell divides to produce ____ haploid daughter cells.**
(a) 2 (b) 3 (c) 4 (d) 5

42. **German biologist Oscar Hartwig discovered meiosis in:**
(a) 1876 (b) 1867 (c) 1786 (d) 1768

43. **Chromatin condenses and takes the shape of chromosomes in:**
(a) Metaphase-I (b) Anaphase-I (c) Prophase-I (d) Telophase-I

44. **Homologous chromosomes pair up in a process called:**
(a) Metastasis (b) Binary fission (c) Synapsis (d) Crossing over

45. **Crossing over occurs in:**
(a) Anaphase-I (b) Telophase-I (c) Prophase-I (d) Metaphase-I

46. **During which phase, two haploid sets of chromosomes are formed?**
(a) Metaphase-I (b) Prophase-I (c) Anaphase-I (d) Telophase-I

47. ***During* which phase spindles disappear and a new nuclear envelope is made around each haploid set?**
(a) Prophase-I (b) Telophase-I (c) Metaphase-I (d) Anaphase-I

48. **The chromosomes uncoil into chromatin during**
(a) Metaphase-I (b) Anaphase-I (c) Telophase-I (d) Prophase-I

49. During _____ one chromosome is pulled toward one pole and the other towards opposite pole.
(a) Telophase-I (b) Anaphase-I (c) Metaphase-I (d) Prophase-I

50. The tetrads attached with spindle fibres align along the equator during:
(a) Prophase-I (b) Anaphase-I (c) Metaphase I (d) Telophase-I

51. During which phase two spindle fibres from both poles attach with one chromosomes of the pair?
(a) Telophase-I (b) Metaphase-I (c) Anaphase-I (d) Prophase-I

52. The nucleoli disappear and nuclear envelope breaks during:
(a) Metaphase-I (b) Prophase-I (c) Telophase-I (d) Anaphase-I

53. During this phase the centrioles migrate to opposite poles and make spindle fibres to which chromosomes attach:
(a) Prophase-I (b) Telophase-I (c) Metaphase-I (d) Anaphase-I

54. The nucleoli and nuclear envelope disappear during.
(a) Anaphase-II (b) Prophase-II (c) Telophase-II (d) Metaphase-II

55. The chromatin condenses during:
(a) Metaphase-II (b) Telophase-II (c) Prophase-II (d) Anaphase-II

56. During which phase the centrioles move to the poles, forming spindle fibres.
(a) Prophase-II (b) Anaphase-II (c) Metaphase-II (d) Telophase-II

57. The spindle fibres attach to the kinetochores of chromosomes, aligning them at the equator of the cell during:
(a) Anaphase-II (b) Telophase-II (c) Metaphase-II (d) Prophase-II

58. Spindle fibres pull sister chromatids apart toward opposite poles during:
(a) Anaphase-II (b) Telophase-II (c) Prophase-II (d) Metaphase-II

59. During this phase, chromosomes uncoil back into chromatin:
(a) Anaphase-II (b) Prophase-II (c) Telophase-II (d) Metaphase-II

60. Nuclear envelopes reform and cytokinesis occurs during.
(a) Anaphase-II (b) Telophase-II (c) Prophase-II (d) Metaphase-II

61. After meiosis-II, how many daughter cells are formed?
(a) 2 (b) 3 (c) 4 (d) 6

62. Meiosis occur in:
(a) Somatic cells (b) Germ live cells (c) Daughter cells (d) Parent cells

ANSWERS:

1.	(d)	2.	(c)	3.	(b)	4.	(a)	5.	(b)	6.	(b)	7.	(a)
8.	(c)	9.	(d)	10.	(a)	11.	(a)	12.	(b)	13.	(d)	14.	(b)
15.	(a)	16.	(b)	17.	(c)	18.	(b)	19.	(c)	20.	(c)	21.	(b)
22.	(d)	23.	(c)	24.	(b)	25.	(a)	26.	(b)	27.	(c)	28.	(b)
29.	(d)	30.	(b)	31.	(b)	32.	(a)	33.	(b)	34.	(b)	35.	(a)
36.	(b)	37.	(b)	38.	(a)	39.	(b)	40.	(c)	41.	(c)	42.	(a)
43.	(c)	44.	(c)	45.	(c)	46.	(c)	47.	(b)	48.	(c)	49.	(b)
50.	(c)	51.	(b)	52.	(b)	53.	(a)	54.	(b)	55.	(c)	56.	(a)
57.	(c)	58.	(a)	59.	(c)	60.	(b)	61.	(c)	62.	(b)		

1. **What is *the main* purpose of mitosis?**
   (a) To produce genetically identical daughter cells
   (b) To produce genetically diverse daughter cells
   (c) To produce gametes
   (d) To reduce the number of chromosomes
2. **Which of the following is a unique stage of meiosis that does not occur in mitosis?**
   (a) Prophase (b) Metaphase (c) Anaphase (d) Prophase I
3. **How cell division takes place in Prokaryotes?**
   (a) Mitosis (b) Meiosis (c) Binary fission (d) None of these
4. **Which form of cell division create cells with new combinations of genes?**
   (a) Mitosis (b) Meiosis (c) Budding (d) Binary fission
5. **The cell replicates and making an exact copy of its genetic material in:**
   (a) G1 Phase (b) G2 Phase (c) S Phase (d) M Phase
6. **The centromere which is the specialized region of the chromosome where spindle fibres attach during cell division is absent in:**
   (a) Prokaryotes (b) Eukaryotes (c) Algae (d) Fungi

ANSWERS:

1. (a) 2. (d) 3. (c) 4. (c) 5. (c) 6. (a)

Additional Short Questions

4.1 Cell Cycle

4.2 Mitosis

1. What is cell cycle.

Ans. Cell cycle is a series of events starting after cell divisions to the next division.

2. What are two main phases of cell cycle?

Ans. Two main phases of cell cycle are:

- Interphase
- Mitosis phase

3. What does happen during interphase?

Ans. During interphase, the cell performs the life functions according to its specialty and prepares itself four next division.

4. Which phases does interphase consist of?

Ans. Interphase consists of three phases:

- G1 Phase (First Gap Phase)

- S phase (Synthesis phase)
- G2 Phase (Second Gap prese)

5. Which phase does start from the end of the mitosis phase?

Ans. G1 phase starts from the end of the mitosis phase.

6. Which phase of interphase is called growth phase?

Ans. G1 phase (First Gap Phase) is also called the growth phase.

7. What does happen during G1 phase?

Ans.
- During this phase cell makes protein's and organelles and so grows in size.
- Cell also makes enzymes that are required in S phase for the replication of DNA.

8. In which phase of interphase DNA of each chromosome is replicated (copied)?

Ans. During S phase (Synthesis phase), the DNA of each chromosome is replicated (Copied).

9. What das happen during G2 phase?

Ans.
- During G2 phase, the cell continues to grow and produces proteins necessary for cell division
- The cell checks for any DNA damage that may have occurred during replication and makes necessary repairs.
- The cell also begins to reorganize its contents in preparation for mitosis.

10. What is G0 phase?

Ans. It is a phase during which many cells stop dividing and start performing their specific functions.

11. Which cells do remain in G0 phase for indefinite periods?

Ans. Neurons remain in G0 for Indefinite periods.

12. Which cells do remain in G0 phase temporarily?

Ans. Cells of liver and kidney remain in G0 phase temporarily.

13. Which cells do not enter G0 phase throughout life?

Ans. Epithelial cells do not enter G0 phase and continue to divide throughout life.

14. What is mitosis?

Ans. Mitosis is the type of cell division in which a cell divides into two daughter cells, each with the same number of chromosomes.

15. In which cells does mitosis occur?

Ans. Mitosis occurs in the somatic cells of eukaryotes.

16. How do prokaryotes make identical cells?

Ans. Prokaryotes divide to make identical cells by binary fission.

17. Who discovered mitosis?

Ans. The German biologist, Walther Fleming discovered the events of mitosis in 1880s.

18. What are major phases of mitosis?

Ans. There are 2 major phases of mitosis:

- Karyokinesis (division of nucleus)
- Cytokinesis (division of cytoplasm)

19. What is Karyokinesis. What are its further phases?

Ans. Karyokinesis means the division of the nucleus. It is further divided into four phases.

- Prophase
- Anaphase
- Metaphase
- Telophase

20. Differentiate between chromatin and chromosomes.

Ans. Chromatin:

During interphase (non-dividing phase) of cell, chromosomes are in the form of fine thread like structure known as chromatin.

Chromosomes:

One of the rod shaped bodies fecund In the nucleus of cells that contain genetic information (GNA).

21. Define Somatic cells.

Ans. Those cells which give rise to cells of animal bodies are called somatic cells. Somatic cells undergo mitosis.

22. Define germ live cells.

Ans. Germ line cells are those which give rise to gametes. Germ line cells undergo meiosis.

23. What is metaphase plate?

Ans. Metaphase plate is a plate formed when during metaphase, the chromosomes attached with spindle fibres arrange themselves along the equator of the cell.

24. Differentiate between diploid and haploid cells.

Ans. Diploid cells:

Those cells in which chromosomes are found in pair form i.e. (2n), are Known as diploid cells.

Haploid cells:

Those cells which have half number of chromosome i.e. (1n), are known as haploid cells.

25. What is phragmoplast?

Ans. In plant cells, Golgi apparatus makes vesicles. There vesicles move to the middle and fuse to form a plate called phragmoplast.

26. What is growth?

Ans. Growth in organisms means am increase in size and the number of cells.

27. What is role of mitosis in growth?

Ans. Mitosis plays a crucial role in growth by producing new cells that are identical to the original cell.

28. What is regeneration?

Ans. Regeneration is the process that cells in an organism go through to restore damage to or replace cells in order to repair them.

29. How does hydra reproduce?

Ans. Hydra reproduces asexually bay budding.

30. What is the difference between benign and malignant tumor.

Ans. Benign tumor:

If the tumors remain in their original location, they are called benign.

Malignant tumor:

If the tumors migrate are invade other tissues, they are called malignant tumor.

31. What is metastasis. Write is its role in cancer?

Ans. Metastasis:

Malignant tumors can send the cancer cells to other parts of body where new tumors may form. This phenomenon is called metastasis.

Role:

In metastasis when tumors spread within body they destroy further normal cells to form cancerous tumors. This process help in spread of cancerous.

4.3 + 4.4 Meiosis + Comparison Between Meiosis and Mitosis

32. What is meiosis?

Ans. Meiosis is the type of cell division, in which each daughter cell receives half the number of chromosomes as compared to parental cell.

33. Who discovered meiosis?

Ans. German biologist Oscar Hartwig, discovered meiosis in 1876.

34. What are divisions of meiosis?

Ans. Meiosis Consists of two divisions

- Meiosis I
- Meiosis II

35. What are different phases of meiosis I?

Ans. Different phases of meiosis-I are:

- Prophase-I
- Metaphase-I
- Anaphase-I
- Telophase-I

36. What are different phases of meiosis-II?

Ans. Different phases of meiosis-II are:

- Prophase-II
- Metaphase-II
- Anaphase-II
- Telophase-II

37. What is synapsis?

Ans. Homologues chromosomes move close together. They pair up in a process called Synapsis.

38. What is tetrad?

Ans. Each pair of homologous chromosomes is referred as tetrad.

39. What is chiasmata?

Ans. Chiasmata is a X-shaped structures formed when non-sister chromatids of homologues chromosomes become zipped together.

40. What is crossing over?

Ans. The phenomenon in which non-sister chromatids of homologues chromosomes exchange their segments is called crossing over.

41. Differentiate between disjunction and non-disjunction.

Ans. Disjunction:

The normal separation of chromosomes in meiosis is termed as disjunction.

Non-disjunction:

The separation is not normal it is known as non-disjunction.

42. How many cells are there in human body?

Ans. There are about 200 trillion cells in human body.

43. What is kinetochore?

Ans. Kinetochore is a complex protein structure that is the point where spindle fibres attach.

44. Write role of mitosis in regenation.

Ans. Some organisms can regenerate parts of their bodies. The production of new cells is achieved by mitosis.

45. When sister chromatids separate during mitosis and meiosis?

Ans. In mitosis, sister chromatids separate during anaphase. While in meiosis, it happens in anaphase-II.

46. Why does cytokinesis occur in mitosis and meiosis?

Ans. Cytokinesis occurs at the end of both divisions. During Cytokinesis, the cytoplasm divides and two new cells are formed.

Conceptual Short Questions

1. What are the events occuring in the prophase of mitosis?

Ans. During prophase, chromatin condenses and make thick chromosome. Nuclear envelop and nucleolus break down. The Centro some of cell duplicates.

2. How asexual reproduction occurs in hydra?

Ans. Hydra reproduces a sexually by budding. During this process mitosis forms a mass of cells called bud on the surface of Hydra. Mitosis continues in the cells of bud and it grows into a new individual.

3. Differentiate between chiasmata and crossing over.

Ans. Chiasmata: Non-sister chromatids of homologous chromosome become "zipped" together, forming x-shaped structures called chiasmata.

Crossing over: Crossing over is the exchange of portions of chromosomes between non-sister chromatids.

4. Which events of prophase and prophase-I are similar?

Ans. The similar events of prophase and prophase - I are nucleoli disappear and nuclear envelope breaks. Centrrioles migrate to opposite poles and make spindle fibers to which chromosomes attach.

5. Why meiosis-II is important after meiosis - I?

Ans. Meiosis-II is important after meiosis. I because it ensures that each daughter cell receives only one set of chromosomes, maintaining the correct number of chromosomes in the resulting gametes (sperm or egg cells.)

A. Select the correct answers for the following questions.

1. In which phase of cell cycle, maximum growth occurs in cell?

a) M phase b) S phase c) G1 phase d) G2 phase

2. In which phase of cell cycle, the chromosomes duplicate?

a) Mitosis b) G1 phase c) G2 phase d) S phase

3. Which of the following is NOT a characteristic of mitosis?

a) It occurs in somatic cells.
b) It results in genetically identical daughter cells.
c) The chromosome number is halved in daughter cells.
d) It results in the formation of two daughter cells.

4. At which stage of mitosis chromosomes line up in the centre?

a) Prophase b) Metaphase c) Anaphase d) Telophase

5. If you observe a cell in which nuclear membrane is reforming around two sets of Chromosomes, what stage of cell cycle is this?

a) Anaphase b) Telophase c) Prophase d) Metaphase

6. How does the centrosome contribute to mitosis?

a) Initiates DNA replication b) Makes mitotic spindle
c) Forms the nuclear envelope d) Duplicates organelles

7. Centrosomes make mitotic spindle in;

a) Animal cells b) Plant cells c) Prokaryotic cells d) All of these

8. An organism has 4 pairs of chromosomes. After meiosis-I, how many chromosomes and chromatids will be present in each daughter cell?

a) 8 chromosomes and 16 chromatids b) 4 chromosomes and 8 chromatids
c) 4 chromosomes and 4 chromatids d) 8 chromosomes and 8 chromatids

9. Which event is unique to meiosis but not mitosis?

a) DNA replication b) Chromosome alignment
c) Crossing over d) Nuclear division

10. Why is meiosis II necessary after meiosis I?

a) To replicate chromosomes b) To reduce chromosome number
c) To separate sister chromatids d) To ensure genetic recombination

ANSWERS:

1. (c)	**2.** (d)	**3.** (c)	**4.** (b)	**5.** (b)
6. (b)	**7.** (a)	**8.** (a)	**9.** (c)	**10.** (c)

B. Write short answers.

1. Enlist the events that occur during the G1 phase of interphase?

Ans. Following events occur during the G1 phase of interphase.

- Cell makes proteins and organelles and so grow in size.
- Cells also make enzymes that are required in S phase for the replication of DNA.

2. What is the main purpose of the S phase in the cell cycle?

Ans. The main purpose of S phase in the cell cycle is to copy all of its DNA, doubling the amount of DNA in the cell.

3. During which phase of mitosis sister chromatids separate?

Ans. During anaphase of mitosis the sister chromatids separate and move towards the poles of the cell.

4. How does crossing over contribute to genetic variation in meiosis?

Ans. Crossing over is a genetic process that occurs during prophase-I of meiosis when homologous chromosomes exchange DNA, resulting in new combinations of genes and genetic variation, which is essential for evolution in multicellular organisms.

5. What is the role of spindle fibres in mitosis?

Ans. During mitosis, spindle fibres, also known as the mitotic spindle form a protein structure that divides the genetic material in a cell. This spindle is necessary to equally divide the chromosomes of a parental cell into two daughter cells.

6. How is cytokinesis in animal cell different from plant cell?

Ans. **Cytokinesis in animal cell:**

In animal cell, during cytokinesis, a furrow develops at the equator. At this furrow, the cytoplasm has a ring of microfilaments. The ring contracts and the furrow moves inward. In this way parent cell is pinched into two.

Cytokinesis in plant cell:

In plant cell, during cytokinesis, golgi apparatus makes vesicles. These vesicles move to the middle and fuse to form a plate called phragmoplast. The plate grows outward and its membranes fuse with the cell membrane. This results in two daughter cells.

7. What is the difference between prophase of mitosis and prophase-I of meiosis-I?

Ans. Difference between prophase of mitosis and prophase-I of meiosis-I

Prophase of Mitosis	Prophase-I of Meiosis-I
• It has the shortest duration.	• It has the longest duration.
• Homologous chromosomes remain separate.	• Homologous chromosomes come close together to form a pair.
• No crossing over occurs.	• Crossing over occur leading to exchange of chromatid segments.

8. How does meiosis differ from mitosis in terms of chromosome number?

Ans. Mitosis produces two daughter cells, each with the same number of chromosomes as were present in the parent cell. For example, if the parent cell has 46 chromosomes, the daughter cells will also have 46 chromosomes.

On the other hand meiosis produces daughter cells, each with half the number of chromosomes as the parent cell. For example, if the parent cell has 46 chromosomes, the daughter cells will each have 23 chromosomes.

9. What are the key events of anaphase in mitosis?

Ans. Key events of Anaphase in mitosis:

- The spindle fibres attached with chromosomes pull towards the poles.
- The chromosomes sister chromatids separate.
- Two similar sets of chromatids move towards the poles of the cell.

10. What is the function of the centrosome during cell division?

Ans. The function of centrosome during cell division is to organize microtubules that form the mitotic spindle, which separates replicated chromosomes into daughter cells.

11. What are sister chromatids, and when do they separate in meiosis?

Ans. Sister chromatids are the identical copies of a chromosome that are formed during DNA replication and are joined at the centromere.
Sister chromatids separate during anaphase II of meiosis.

12. How is mitosis related to the process of regeneration?

Ans. Mitosis is a cell division that helps with regeneration by producing identical copies of cells that can replace damaged or worn out cells.

C. Write answers in detail.

1. Describe the events that occur during the phases of mitosis.

Ans. For answer see Q.3

2. Describe cytokinesis in animal and plant cells.

Ans. For answer see Q.4

3. Describe the significance of mitosis.

Ans. For answer see Q.5

4. Describe the events that occur during the phases of meiosis-I.

Ans. For answer see Q.7

5. Describe the significance of meiosis.

Ans. For answer see Q.9

D. Inquisitive questions.

1. What role might mistakes in the cell cycle checkpoints play in the emergence of cancer?

Ans. Cell cycle check point play a crucial role in preventing cancer by ensuring that damaged cell do not divide and promote cancer cells. Following check points in cell cycle can mointered. G1 phase, G2 phase, S phase, M phase
Detection of DNA damage and spindle phase assembly check point.

2. Why do skin cells divide continuously throughout an organism's existence, but nerve and muscle cells permanently exit the cell cycle?

Ans. Through out the life to replace damaged or dead cells, while nerve and muscle cells have limited regenerative capacities and exist in a permanent post mitotic state due to their specialized functions an limited cell dividing capacity.